Preliminary Notes on Molluscan Assemblages of the Submarine Banks Around the Izu Islands

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It is well known that there are several submarine banks along the submerged rise which extends southwestward from the southern tip of Izu Peninsula, central Honshu. Small islands such as Toshima, Niijima, Shikine, and Kozu, with several other islets, lie on this rise. These, together with a few other islands situated farther south, are called the Izu Islands. They are linked by a volcanic system, and there is a considerable number of such banks in the neighborhood. A few papers concerned with hydrographical, bathymetrical, and faunistic characteristics of these submarine banks have been prepared by Suzuki and Sato (1944), Niino (1935, 1952, 1955), and Shirai (1958). On the basis of these works, together with information furnished by the present author, Horikoshi (1957) discussed the topographical peculiarity in relation to the general molluscan fauna on these banks.

Another group of submarine banks is found around the Osumi Islands, south of Kyushu. Presumably their hydrographical and bathymetrical characters are similar to those banks mentioned above, but no information about the molluscan fauna has been available until now.

As a contribution to knowledge about molluscan fauna on the submarine banks and insular shelves around the Izu Islands, this paper deals with the general account of the molluscan assemblages of the area and their faunal similarity to another series of banks near the Osumi Islands in the Kuroshio area. It is based on biological dredge samples collected chiefly by research vessels during 1955–59.

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Topography of Submarine Banks Around Izu Islands

The Izu Islands extend from the mouth of Sagami Bay to the south. In the northern group are (Izu-)Oshima, Toshima, Niijima, Shikine, and Kozu. To the south there are Miyake, Mikura, Hachijo, Aogashima, and Torishima as the southern extremity (Figs. 1, 2). The banks are usually isolated from the series of these islands, with depressions deeper than 200 m lying between them. The tops of such types of banks are usually flat and about 80–120 m in depth. They are usually elongate-oval in shape with the axis in a northeast-southwest direction.

The Hyotanse Bank, one of the representatives of this series of banks, located west of Kozu Island, has been described by Niino (1955) as follows: The slopes around the bank are steep and rocks are exposed there; gravels and coarse material cover the broad and flat plain on its top; andesite and basalt, which are very common in the bedrock, are found mingled with liparite gravels together with a number of manganese concretions from the bank; the lithological characters of these rocks are the same as those of the main islands in the Fuji Volcanic Zone. According to gross observation of the present material, the sediments (gravels and shells) are heavily coated by calcareous algae.

The bottom of Zenisu Bank, also studied by Niino (1935), reveals coarse sand and shells,

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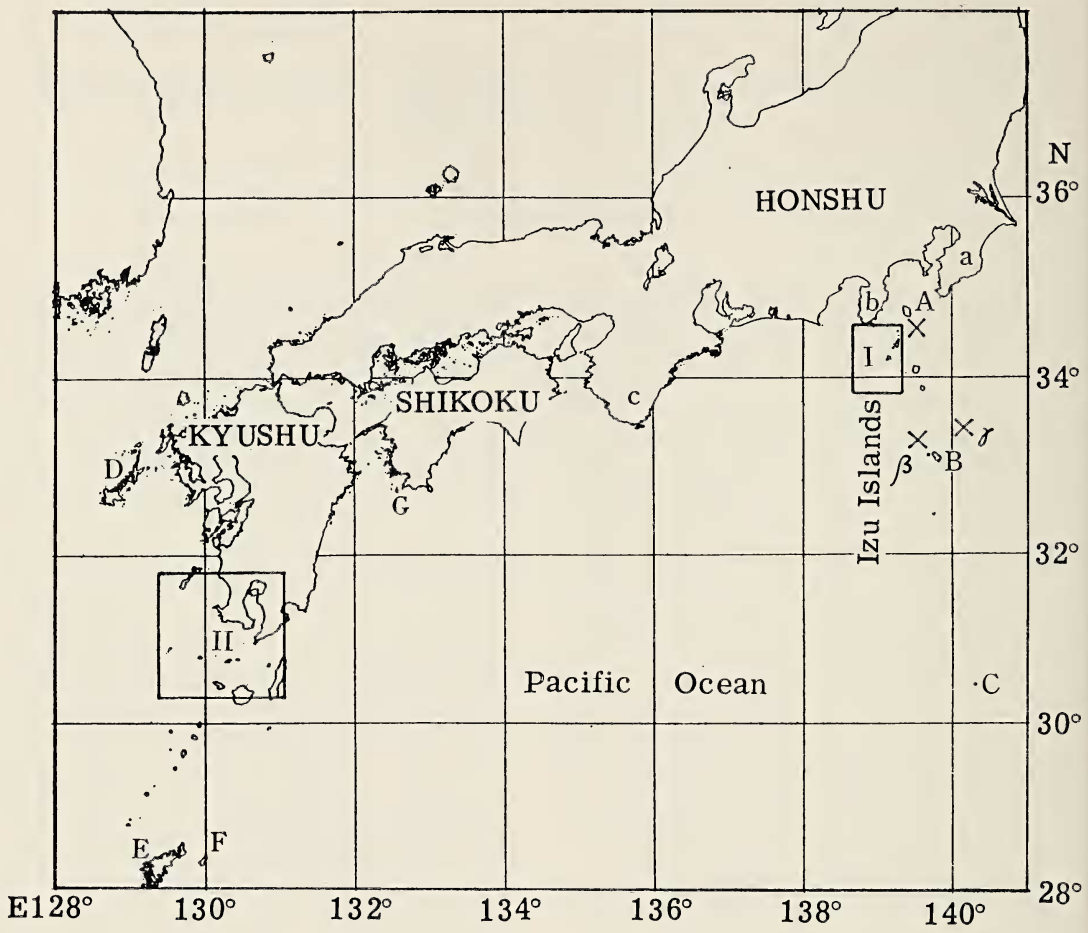

FIG. 1. Index map for the position of submarine banks and other localities. *a*, Boso Peninsula; *b*, Izu Peninsula; *c*, Kii Peninsula. *A*, (Izu-) Oshima Is.; *B*, Hachijo Is.; *C*, Torishima Is.; *D*, Goto Islands; *E*, Amami-Oshima Is.; *F*, Kikaijima Is.; *G*, Okinoshima Is. in the Bungo Straits. α, Omurodashi (bank); β, Kurose (bank); γ, Shinkurose (bank). (See Figs. 2 and 3 for details of areas I and II, respectively.)

and several steep rocks are exposed above the sea surface. At Watarinose Bank, which lies between Kozu Island and Zenisu, the character of the bottom is supposedly generally the same as that at Zenisu. The neighboring waters of those banks are noted as excellent fishing grounds. Kurose and Shinkurose are the southern banks situated around Hachijo Island. The bottom characters of these two are known to be similar to that of Hyotanse. On the other hand, Omurodashi Bank off Izu-Oshima is said to be different from the others in having a sandy mud sediment at its top.

The geographical positions of the submarine banks of Izu Islands under study are referred to in Figures 1 and 2.

OCCURRENCE OF SPECIES BY AREA

1. Hyotanse Bank

MATERIAL: Dredged by the R.V. "Soyomaru" on Nov. 20 and 23, 1955, at 7 stations from depths of 118, 135, 140, 145, 148, 153, and 170–230 m.

EARLIER WORKS: Niino (1955) reported 11

species of Pelecypoda and 5 species of Gastropoda. Shirai (1958) reported 5 pelecypods and 5 gastropods.

SPECIES IN THE PRESENT MATERIAL: *Acar congenitum* (Smith); *Mimarcaria aizoi* Sakurai (MS), 137 m; *Striarca fausta* Habe, 137 m; *Samacar pacifica* (Nomura and Zimbo), 137 m; *Barbatia tamikoae* Sakurai (MS), 140 m; *Pseudogrammatodon obliquatus* Yokoyama, var.; *Nipponolimopsis decussata* (A. Ad.), 145 m; *Tucetona shinkurosensis* Hatai, Niino and Kotaka; *Malleus irregularis* (Jousseaume), var., 118 m; *Chlamys mollita* (Rve.), 118 m; *C. lemniscata* (Rve.), 118 m; *C. vesiculosus* (Dkr.); *C. tissotii* (Bernard), 153 m; *Spondylus anacanthus* (Mawe); *Limatula japonica* (A. Ad.); *Lima fujitai* Oyama; *Septifer grayana* (Dkr.); *Cardita nodulosa* (Lamarck), 153 m; *Glans sagamiensis* Kuroda and Habe; *Chama argentata* Kuroda and Habe; *Frigidocardium eos* (Kuroda), 140 m; *Meiocardia tetragona* (Ad. and Rve.); *Emarginula fragilis* Yokoyama, 153 m; *E. teramachii* Habe; *Microgaza* sp. aff. *sericata* Kira, 153 m; *Talopena lifuana* (Fischer), 153 m; *Galeoastraea guttata* (A. Ad.), 153 m; *Tenagodus anguinus* (L.), 140 m; *Serpulorbis medusae* Pilsbry, 140 m; *Apollon hirasei* Kuroda and Habe, 145 m; *Phanozesta semitorta* Kuroda and Habe, 135 m; *Latiaxis pagodus* (A. Ad.), 137 m; *Bursa ranelloides* (Rve.), var., 135 m; *Mitrella* sp. cf. *lischkei* (Smith); *Conus gratacapy* Pilsbry, 170 m; *Conus* sp., 153 m.

OTHER SPECIES REPORTED BY NIINO: *Tucetona hanzawai* (Nomura and Zimbo); *Limopsis tajimae* (Yokoyama); *Hawaiarca uwaensis* (Yokoyama); *Plicatula muricata* (Sowerby); *Trichomusculus coralliophaga* (Gmelin); *Lima basilanica* (Ad. and Rve.), 260 m; *Ctenoides annulata* (Lamarck), 260 m; *Pecten albicans* (Schröter); *Lucinoma spectabilis* (Yokoyama); *Perotrochus beyrichii* (Hilgendorf), 134, 160, 128 m.

MOLLUSCS REPORTED ONLY BY SHIRAI: *Limopsis obliqua* A. Ad., 250 m; *Septifer excisus* (Wiegmann), 104 m (this may be *S. grayana*); *Fragum loochooanum* Kira, 250 m (this may be *Glans sagamiensis*); *Galeoastraea millegranosa* Habe, 260 m (this may be *G. guttata*); *Siliquaria cumingii* Mörch, 260 m (this may be *Tenagodus anguinus*).

2. Zenisu Bank

MATERIAL: Dredged by the R.V. "Soyo-maru" on Nov. 20, 1955, at 2 stations from depths of 85 and 170 m.

EARLIER WORKS: Niino (1935) reported on the bottom character only.

SPECIES IN THE THE PRESENT MATERIAL: *Acar congenitum* (Smith); *Hawaiarca uwaensis* (Yokoyama), 170 m; *Pseudogrammatodon obliquatus* (Yokoyama); *Pectunculina cernata* (A. Ad.); *Limopsis cumingii* A. Ad.; *Tucetona shinkurosensis* Hatai, Niino and Kotaka, 170 m; *Glycymeris rotunda* (Dkr.); *Polynemamussium intuscostatum* (Yokoyama); *Chlamys vesiculosus* Dkr.; *C. tissotii* (Bernardi); *C. lemniscata* (Rve.); *Plicatula muricata* (Sowerby); *Spondylus anacanthus* (Mawe); *Pecten albicans* (Schröter); *Lima zushiensis* (Yokoyama); *Volsella* sp.; *Pycnodonta musashiana* (Yokoyama); *Meiocardia tetragona* (Ad. and Rve.); *Frigidocardium eos* (Kuroda); *Poromya flexuosa* (Yo-

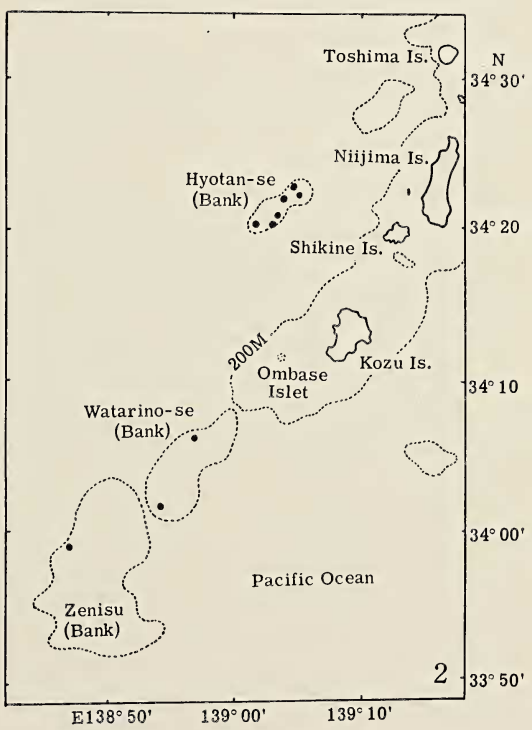

FIG. 2. Detail for I in Fig. 1. Dots indicate the biological stations for the R.V. "Soyo-maru" in Nov., 1955.

koyama); *Verticordia japonica* A. Ad.; *Emarginula incisura* A. Ad.; *Bursa ranelloides* (Rve.), var.; *Distorsio* sp.

3. Watarinose Bank

MATERIAL: Dredged by the R.V. "Soyo-maru" on Nov. 20, 1955, at 2 stations from depths of 80–100 m and 140–220 m.

EARLIER WORKS: None.

SPECIES IN THE PRESENT MATERIAL: *Acar congenitum* (Smith); *Barbatia tamikoae* Sakurai (MS); *Samacar pacifica* (Nomura and Zimbo); *Tucetona shinkurosensis* Hatai, Niino and Kotaka; *Malleus irregularis* (Jousseaume), var.; *Chlamys mollita* (Rve.); *C. lemniscata* (Rve.); *Lima fujitai* Oyama; *Astraea okamotoi* Kuroda and Habe; *Galeoastraea guttata* (A. Ad.); *Casmaria cervica* (Sowerby)?; *Tenagodus anguinus* (L.); *Clavus* sp. aff. *rufovaricosa* Kuroda (MS).

4. Toshimatai Bank and Niijima Nishitai Bank (Toramaguri)

MATERIAL: None is available for the present study except *Glans sagamiensis* Kuroda and Habe and *Conus kinoshitai* Kuroda from Niijima-Nishitai.

EARLIER WORKS: Niino (1955) reported 19 pelecypods and 4 gastropods from Toramaguri and a single gastropod from Toshimatai. Shirai (1958) reported 9 bivalves and 4 univalves from Niijima-Nishitai Bank.

SPECIES REPORTED BY NIINO AND SHIRAI: Toshimatai Bank—*Tucetona shinkurosensis* Hatai, Niino and Kotaka; *Hiatella arctica orientalis* Yokoyama; *Perotrochus beyrichii* (Hilgendorf), 88 m.

Niijima-Nishitai Bank—*Barbatia plicata* (Dillwyn) (probably *A. congenitum*), 120 m; *Tucetona shinkurosensis* Hatai, Niino and Kotaka, 104 m; *Chlamys pelseneeri* Dautzenberg and Bavay, 120 m; *C. vesiculosus* Dkr., 78 m; *Lima zushiensis* Yokoyama, 73 m; *Lima fujitai* Oyama, 104 m; *Limatula japonica* A. Ad., 104 m; *Crassatellites oblongatus* (Yokoyama), 120 m; *Venus toreuma* Gould, 78 m; *Aloides venusta* (Gould), 120 m; *Perotrochus beyrichii* (Hilgendorf), 104, 120 m; *Emarginula fragilis* Yokoyama, 104 m; *E.* sp., 104 m; *Puncturella fastigiata* A. Ad., 78 m; *Trivirostra oryza* (Lamarck), 88 m.

5. Ombase Islet (near Kozu Island)

MATERIAL: A part of the specimens dredged by the R.V. "Tonan-maru" at depths of 32, 55, 60, and 100 m. These were examined by courtesy of Mr. Kurata.

EARLIER WORKS: Igarashi and others (1956) reported on the bottom character and upon piscifauna from the viewpoint of fishing ground investigation.

SPECIES IN THE PRESENT MATERIAL: *Samacar pacifica* (Nomura and Zimbo), 60 m; *Barbatia* sp.; *Tucetona shinkurosensis* Hatai, Niino and Kotaka, 32 m; *Glycymeris amamiensis* Kuroda, 32 m; *Venus toreuma* Gould; *Galeoastraea guttata* (A. Ad.), 55, 100 m.

6. Kurose and Shinkurose

MATERIAL: Collected from Kurose Bank at a depth of ca. 200 m by *Corallium* fishing net of the R.V. "Tonan-maru." Examined by courtesy of Mr. Kurata.

EARLIER WORKS: Niino (1952) surveyed around Shinkurose Bank and reported 13 gastropods, 20 pelecypods including 3 new forms, and 1 scaphopod.

SPECIES IN THE PRESENT MATERIAL: Kurose Bank—*Acar congenitum* (Smith); *Arca mauia takii* Hatai, Niino and Kotaka; *Barbatia* sp.; *Samacar pacifica* (Nomura and Zimbo); *Lima fujitai* Oyama; *L. quantoensis* Yokoyama; *Crassatellites oblongata* Yokoyama; *Perotrochus beyrichii* (Hilgendorf); *Emarginula* sp.; *Tenagodus anguinus* (L.); *Bursa ranelloides* (Rve.) var.; *Chicoreus laciniatus* (Sowerby); *Conus* sp.

Shinkurose (Niino)—*Arca* sp., 290 m; *Nipponolimopsis nipponica* (Yokoyama), 290 m; *Tucetona hanzawai* (Nomura and Zimbo), 280 m; *Tucetona shinkurosensis* Hatai, Niino and Kotaka, 290 m; *Venericardia ryukyuensis* Nomura and Zimbo, 290 m; *Vasticardium* sp., 280 m; *Chione chlorotica,* 280 m; *Cadulus* sp., 290 m; *Collisella heroldi* (Dkr.), 290 m (a littoral species, may be carried down to the deep by some means); *Margarites cincereus* (Couthouy), 290

m; *Pseudoliotia micans* (A. Ad.), 290 m; *Clathofenella reticulata* (A. Ad.), 290 m; *Mucronalia subulata* (A. Ad.), 290 m; *Tonna luteostoma* Küster, 280 m; *Coralliophaga euginiae* (Bernard), 280 m; *Bursa bufonia* (Gmelin), 280 m; *Conus* sp. (identified as *C. ione* by an illustration in Niino's paper).

7. *Insular Shelf around Hachijo Island*

MATERIAL: None is available here.

EARLIER WORKS: Niino (1952) reported 13 pelecypods and 3 gastropods from depths of 115 and 200 m.

SPECIES REPORTED BY NIINO: *Barbatia hachijojimensis* Hatai, Niino and Kotaka, 115, 200 m; *Arca mauia takii* Hatai, Niino and Kotaka, 200 m; *Tucetona* sp., 200 m; *Spondylus cruentus* Lischke (*S. anacanthus*?), 115 m; *Spondylus* sp.; *Lima lima* L. 115, 200 m; *Pycnodonta musashiana* (Yokoyama), 200 m; *Pseudochama* sp., 200 m; *Vasticardium arenicolum* (Rve.); *Meretrix* sp., 115 m; *Callista pilsbryi* Habe, 200 m; *Venus* sp., 200 m; *Phalium* sp., 115 m; *Ocenebra adunca* (Sowerby), 115 m; *Conus* sp., 115 m.

8. *Insular Shelf around Torishima Island*

MATERIAL: Part of specimens collected by test fishing for *Corallium* operated at a depth of 150–250 m. The material was examined by courtesy of Mr. Kurata.

EARLIER WORKS: None.

SPECIES IN THE PRESENT MATERIAL: *Spondylus anacanthus* (Mawe); *Pycnodonta musashiana* (Yokoyama); *Plicatula muricata* (Sowerby); *Notolimea* sp. cf. *tosana* Oyama; *Chama argentata* Kuroda and Habe; *Tenagodus anguinus* (L.); *Talopena lifuana* (Pilsbry); *Cantharus* sp.

SIMILAR MOLLUSCAN FAUNA FROM SOME BANKS SOUTHWEST OF KYUSHU

On the Pacific Ocean side of Japan, groups of submarine banks other than those mentioned above are scattered throughout the southwestern waters off Kyushu (Figs. 1, 3). These also are situated on the submarine rise of the volcanic system on which the Osumi Group lies; this situation is quite similar to that of the Izu Banks. Hereafter, this second series of banks is tentatively called the Osumi Banks. The tops of these banks are usually at about 100 m, and they are isolated from the neighboring islands by depressions of about 200 m in depth. Their general features are similar to the Izu Banks in that they have submarine sediments of coarse sand and gravel which are coated by calcareous algae. Some rocks exposed at the sea surface are also found (e.g., the Uji Islets).

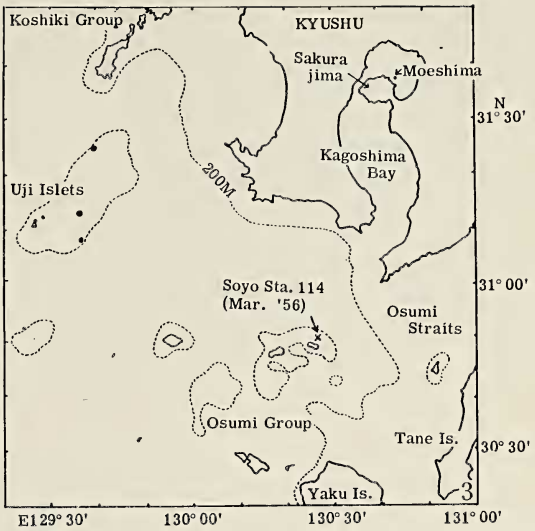

FIG. 3. Detail for II in Fig. 1. Dots indicate the biological stations for the R.V. "Soyo-maru" in Feb., 1959.

Oceanographically, the two series of banks are decidedly exposed to similar conditions with respect to the Kuroshio Current, for the usual main axis of the current passes through the Osumi Straits as well as across the Izu Submarine Ridge.

The occurrence of molluscan species revealed by the present survey is as follows:

9. *Off Takeshima Island*

At a depth of 210 m; dredged by the R.V. "Soyo-maru" on Mar. 5, 1956; sta. 114: 30° 50′ N, 130° 28′ E.

Arca mauia takii Hatai, Niino and Kotaka;

Glycymeris amamiensis Kuroda; *Chlamys mollita* (Rve.); *C. vesiculosus* (Dkr.), var.; *C. tissotii* (Bernardi); *Lima tomlini* Prashad; *Ctenoides japonicus* (Dkr.); *Plicatula muricata* Sowerby; *Septifer grayanus* (Dkr.); *Glans kyushuensis,* n. sp.; *Chama argentata* Kuroda and Habe; *Frigidocardium eos* (Kuroda); *Vasticardium* sp.; *Venus toreuma* (Gould); *Pitar* sp.; *Bursa* sp.; *Galeoastraea millegranosa* Habe; *G. tayloriana* (Smith); *Ceratostoma vespertilis* Kira; *Chicoreus laciniatus* (Sowerby)?; *Polynices* sp.; *Conus* sp.

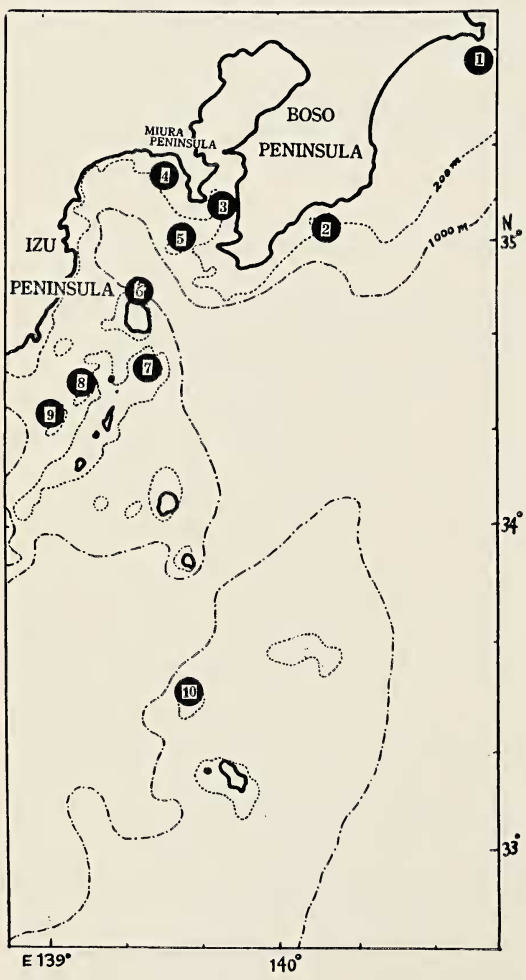

FIG. 4. Distribution of *Perotrochus beyrichii* (Hilgendorf). (See section 12 for numerals on dots.)

10. Uji Islets

At 3 stations from depths of 126–140 m; dredged by the R.V. "Soyo-maru" on Feb. 8, 1959.

Acar congenitum (Smith), 126 m; *Striarca fausta* Habe, 126 m; *Samacar pacifica* (Nomura and Zimbo), 126 m; *Mimarcaria aizoi* Sakurai (MS), 126 m; *Hawaiarca uwaensis* (Yokoyama), 126 m; *Spondylus anacanthus* (Mawe), 126 m; *Chlamys lemniscata* (Rve.), 140 m; *Malleus irregularis* (Jousseaume), 126 m; *Chama argentata* Kuroda and Habe, 126 m; *Atrina penna* Habe, 140 m; *Penicillus giganteus* (Sowerby), 126 m; *Perotrochus salmiana* (Rolle), 126 m; *Serpulorbis medusae* Pilsbry, 126 m; *Emarginula* sp.; *Malluvium otohimeae* (Habe), 140 m; *Bursa ranelloides* (Rve.), var., 126, 140 m; *Semicassis* sp., 140 m.

11. Insular Shelf around Goto Islands

Sakurai (1959, and personal communication) reported the following species which have been collected by *Corallium* fishing nets operated off the Goto Islands; depths of operation may be about 100–200 m.

Mimarcaria aizoi Sakurai (MS); *Barbatia tamikoae* Sakurai (MS); *Acar congenitum* (Smith); *Striarca fausta* Habe; *S. soyoae* Habe; *Chlamys lemniscata* (Rve.); *Dymia argentata* Habe; *Samacar pacifica* (Nomura and Zimbo); *Chama argentata* Kuroda and Habe; *Perotrochus hirasei* Pilsbry.

TYPICAL SPECIES OR SPECIES-GROUPS FOR BANKS-ASSOCIATED MOLLUSCA

Because the present data are not based on quantitative samplings, it is not possible to discuss the matter from a quantitative point of view. However, several species-groups may be indicated as endemic ones (or semiendemic) for submarine banks or insular shelves, because of their frequency or abundance in occurrence.

12. Perotrochus beyrichii (Hilgendorf)
Fig. 5

It is well known that this "living fossil" occurs on the lower shelf around Sagami Bay. The

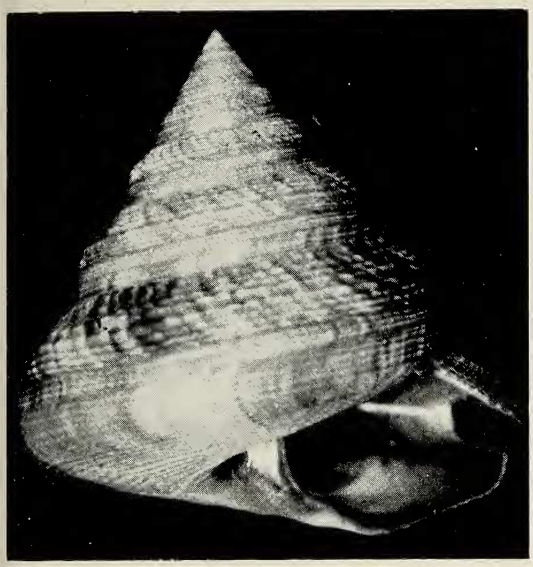

FIG. 5. *Perotrochus beyrichii* (Hilgendorf) from Kurose, ca. 200 m, 72.7 mm × 70.0 mm (Mr. Kurata coll.).

known localities of the species are as follows (numbers for records refer to those of localities shown in Fig. 4):

1) Off Iioka, Pacific side of Boso Peninsula; dead shells collected by commercial trawlers (Sakurai, 1954).
2) Off Hachiman-Saki ("Soyo" sta. 40a; July 4, 1956; 35° 04.7′ N, 140° 21.5′ E), 250 m in depth; a fragment only.
3) West coast of Boso Peninsula, off Katsuyama and Tomiura, about 200–300 m in depth (Wada, 1954).
4) Sagami Bay, west coast of Miura Peninsula. Type locality is off Misaki. Also collected by the H. M. "The Emperor" near Hayama.
5) Okinoyama, a small bank located near the southwestern tip of Boso Peninsula.
6) Senzu, northwestern coast of Oshima Island; dead shell with hermit crab, collected by Mr. Kurata.
7) Around Omurodashi Bank (Shirai, 1958).
8) Hyotanse, 128, 134, 160 m (Niino, 1955).
9) Niijima-Nishitai, 104, 120 m; and Toshimatai, 88 m (Niino, 1955, and Shirai, 1958).
10) Kurose, collected by Mr. Kurata.

As is shown above, this pleurotomariid gastropod is characteristically distributed on the lower shelf and submarine banks around the area. Other species of *Perotrochus,* as ecological equivalents, are also found in similar habitats in other districts; *Perotrochus hirasei* Pilsbry is known to be distributed around the Pacific coast of Kii Peninsula and Tosa Bay, and as an inhabitant of the continental shelf around the main Japanese islands. According to Mr. Teramachi (personal communication), *P. hirasei* has been collected by him from depths of 60 fathoms (ranging 20–180 fathoms) in such localities.

1) Okezoko Deep located south of Okinoshima Islet in Bungo Straits. This is collected from thanatocoenose, mainly of *Glycymeris rotunda,* with *Siphonalia filosa,* etc.
2) Off Urado in Tosa Bay, 70–80 fathoms, sometimes with *Erronea hirasei, Chicoreus dilectus,* and some other common shelf dwellers.
3) Off Tanabe, southwestern coast of Kii Peninsula.
4) Somewhere in Hyuga-Nada, eastern waters off Kyushu.

Recently, Kuroda and Habe (1953) have shown that this species is also distributed in the

FIG. 6. *Perotrochus salmiana* (Rolle) from Uji Islet, 126 m, 65.0 mm × 62.7 mm.

FIG. 7. Distribution of three species of Japanese *Perotrochus*. Dots, *P. beyrichii;* horizontal lines, *P. hirasei;* cross lines, *P. salmiana.*

western waters off Kyushu and around the Goto Islands, where some banks-associated assemblages are found (Sakurai, 1959, and cf *11*). *Perotrochus salmiana* (Rolle) (Fig. 6) is also known from waters off Kii and Tosa provinces. In the present survey, a new locality for this rare species was discovered from the Uji Islets ("Soyo" sta. 72a, Feb. 8, 1959, 31° 24.7′ N, 129° 37.6′ E, 126 m), in company with the similar banks-associated fauna (cf *10*). The smallness of the specimen in the present material may coincide with the fact pointed out by Parker and Curray (1956: 2436), ". . . most of these bank forms were considerably smaller, although they appeared to be mature specimens. . . ."

13. Galeoastraea guttata (A. Adams)
Fig. 8

According to Habe (1958), this fascinating species is distributed around Boso Peninsula and Sagami Bay. As is shown in the map (Fig. 20*a*), this species is characteristically distributed on the banks around the Izu Islands, i. e., Hyotanse, Ombase Islet, and Okinoyama. It is very rare from the insular shelf, despite the fact that there is an example from the Izu Penin-

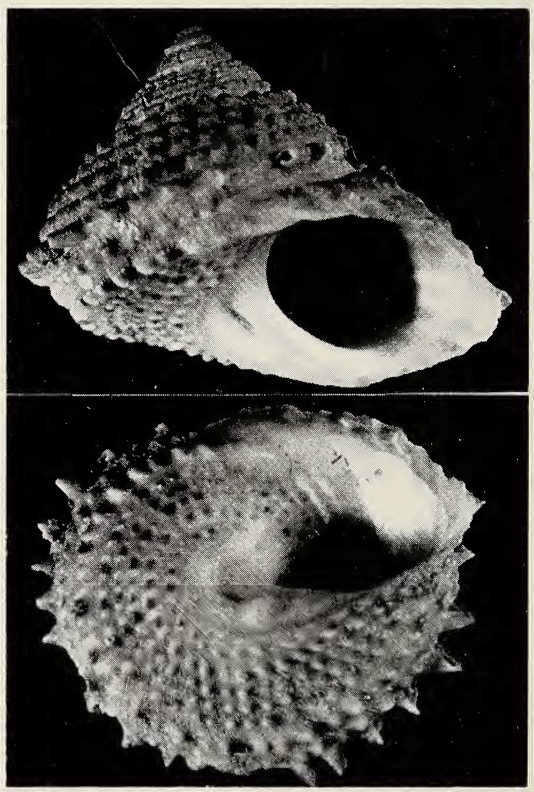

FIG. 8. *Galeoastraea guttata* (A. Adams) from Hyotanse, 153 m, 22.2 mm × 30.3 mm.

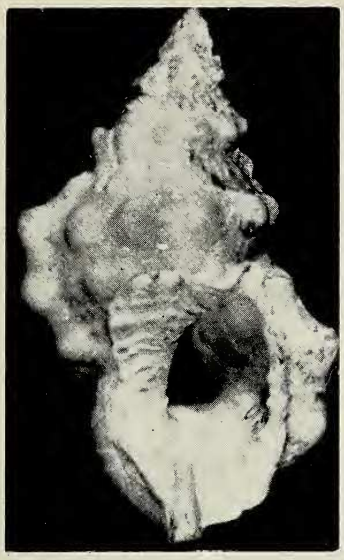

FIG. 9. *Bursa ranelloides* (Reeve) var. from Uji Islet, 140 m, 48.6 mm × 30.3 mm.

sula coast off Iro-Zaki ("Soyo" sta. 42, Apr. 2, 1958, 34° 34.2′ N, 138° 50.7′ E, 80 m). No record from Boso Peninsula is available for the present study. A possible ecological equivalent, *G. millegranosa* Habe, is distributed on the Osumi Banks as well as in its adjacent waters, where *G. guttata* is not found. It is also interesting to note that one of the related species, *Astraea caelata* Gmelin, is indicated by Parker and Curray (1956) as a typical banks-associated mollusca from calcareous banks on the continental shelf off Texas, U.S.A.

14. Bursa ranelloides (Reeve) var.

Fig. 9

A rather small form of the species is widely distributed on the banks mentioned above. It has been collected from Hyotanse, 135 m; Zenisu; Kurose, 200 m; off Takeshima, 210 m, and the Uji Islets, 126 m.

15. Small Arcid Pelecypods

Figs. 10, 11

On the submarine banks under study, some small species of Arcidae are abundant and are found together with other members of the group. The occurrence of species in the present material is as follows:

	IZU BANKS			OSUMI BANKS (KYUSHU)		
	Hyotanse	Zenisu	Kurose	Goto	Uji	Sta. 114
Acar congenitum (Smith)	+	+	+	+	+	—
Arca mauia takii Hatai, Niino, Kotaka	—	—	+	—	—	+
Mimarcaria aizoi Sakurai (MS)	+	—	—	+	+	—
Hawaiarca uwaensis (Yokoyama)	+	+	—	+	+	—
Samacar pacifica (Nomura, Zimbo)	+	—?	+	+	+	—
Striarca fausta Habe	+	—	—	+	+	—

16. Small Pectinid Pelecypods

Figs. 12–14

Chlamys vesiculosus (Dkr.) is known to be very abundant on the continental shelf bordering southwestern Japan. Being a sandy bottom dweller, it is also distributed on the banks of the northern group at a depth of 32–118 m. A related species, *C. tissotii* (Bernardi), often occurs in the same localities. They are not found

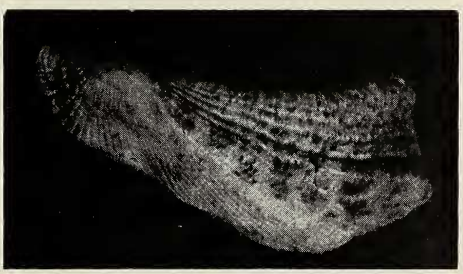

FIG. 10. *Arca mauia takii* Hatai, Niino, and Kotaka from Kurose ca. 200 m, 28.0 mm × 15.0 mm (Mr. Kurata coll.).

on the southern half of Izu Banks but are distributed on the Osumi Banks. *C. lemniscata* (Rve.) is similar in its distribution to the preceding two species; it occurs rather oftener than *C. mollita* (Rve.) does on the banks under study.

	IZU BANKS			OSUMI BANKS	
	Hyotanse	Zenisu	Kurose	Uji	Sta. 114
Chlamys vesiculosus (Dkr.)	+	+	—	+	+
C. tissotii (Bernardi)	+	+	—	+	+
C. lemniscata (Rve.)	+	+	—	+	—
C. mollita (Rve.)	+	—	—	+	+

17. Tucetona hanzawai (Nomura and Zimbo); *T. shinkurosensis* Hatai, Niino, Kotaka
Figs. 15, 16

These small glycymerid species occur on the banks under study. As the former, *T. hanzawai,* originally described from a fossil bed of Ryukyu (Riu Kiu) Limestone, was recorded from Hyotanse and Shinkurose (Niino, 1952, 1955). Hatai, Niino, and Kotaka (in Niino, 1952: 106) stated that "the occurrence of this species in the marine fauna of the environs of Hachijo Island is interesting, because it may suggest the occurrence of a submerged (geological) formation corresponding in age to the Ryukyu Limestone." The latter species has been found from Shinkurose (the type locality), Hyotanse, Zenisu, Watarinose, Niijima-Nishitai, Toshimatai, as well as Ombase Islet (Fig. 20*b*).

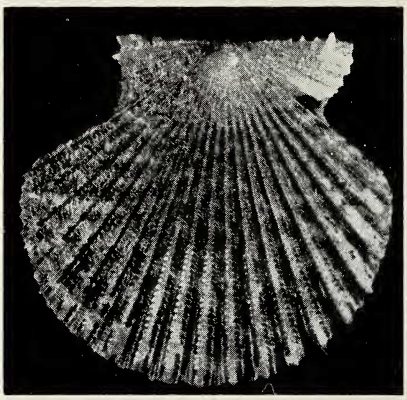

FIG. 12. *Chlamys tissotii* (Bernardi) from Hyotanse, 140 m, 12.6 mm × 13.4 mm.

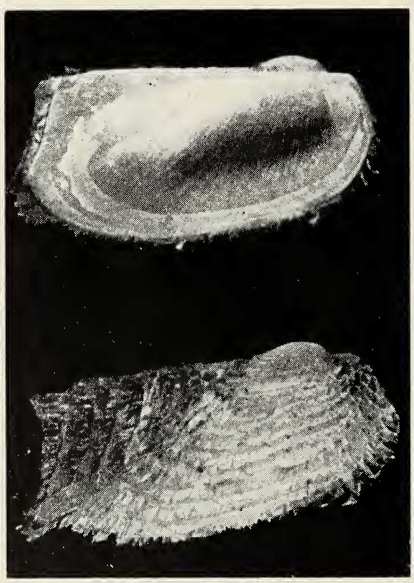

FIG. 11. *Samacar pacifica* (Nomura and Zimbo) from off Miyake Island, 170 m, 12.5 mm × 6.5 mm.

According to Hatai, Niino, and Kotaka (in Niino, 1952), *T. shinkurosensis* (loc. cit. p. 109, figs. 11, 12) is distinguished from *T. hanzawai* (Nomura and Zimbo, 1934, p. 152(44), pl. 5(1), figs. 3a, b: as *Glycymeris*) by the following points: The shell of *T. shinkurosensis* is longer than high, while that of *T. hanzawai* is higher than long; the radial ribs of the former are broad, flat, low, and are 27 in number, while

there are 25 rounded ribs in the latter species; the interspaces of *shinkurosensis* ribs are much narrower than the ribs, while the interspaces of the latter species are nearly equal to the ribs; the hinge teeth of the former are 5 in the anterior half and 6 in the posterior half, instead of 8 and 9 on the anterior and posterior half of the hinge plate of the latter species.

In the present survey, 40 odd valves from Izu Banks were examined. The size ranges of the material were 7.7–17.4 mm in length and 7.6–18.1 mm in height. Of these specimens, no valve was found which had rib interspaces as wide as the ribs themselves, despite the fact that meristic characters vary with individuals, i. e., height/length, ranges 0.915–1.090; number of radial ribs, 24–33; anterior hinge teeth, 5–10; posterior teeth, 7–11. On these evidences, all of the specimens are identified as *T. shinkurosensis*.

The measurements of two odd valves of topotypes of *T. hanzawai* are:

	HEIGHT	HEIGHT/LENGTH	RADIAL RIBS	TEETH	
				Ant.	Post.
No. 1 (left valve)	11.1 mm	1.057	29	7	7
No. 2 (right valve)	12.0 mm	1.190	25	8	7

The interspaces of radial ribs are estimated to be about half as wide as the ribs. In comparison with specimens of two species of similar size, *T. hanzawai* is provided with more distinguishing features than are pointed out in the foregoing lines: it has a more prominent umbo, a deeper shell, and less angular shoulders, thus a *Vasicardium*-like appearance, partly because of its shell which is longer than it is high. Nevertheless, the morphological similarity of these two requires further biometrical study in the future.

18. Chama argentata Kuroda and Habe
Fig. 17

This is found on many banks and insular shelves under study. It was collected from the Niijima-Nishitai Banks, the insular shelf of Torishima, the Uji Islets, insular shelves of Takeshima (Sta. 114), and the Goto Islands (Fig. 20*c*).

Other species than those enumerated above, *Spondylus anacanthus* (Mawe), *Plicatula muricata* (Sowerby), and *Lima fujitai* Oyama (Figs. 18, 19, and 20*d*), are usually found abundantly in the area. The occurrence of two or three of them may be a remarkable faunal characteristic of the banks.

GEOGRAPHICAL DIFFERENCES AND VERTICAL LIMITS OF TYPICAL BANKS-ASSOCIATED ASSEMBLAGES

Since the present material was obtained with different kinds of gear from a limited number of stations, a conclusive quantitative analysis can not be made at present. However, the abundance or probable dominancy of the several

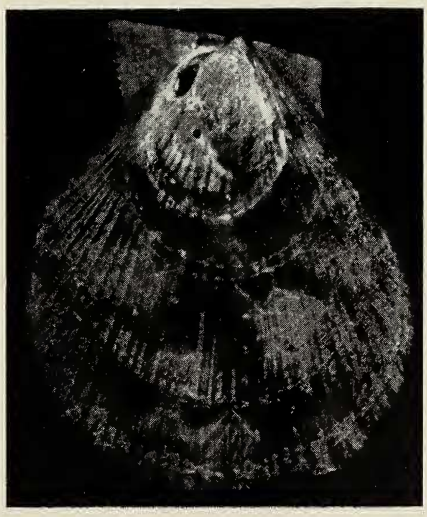

FIG. 13. *Chlamys lemniscata* (Reeve) from Uji Islet, 126 m, 22.0 mm × 20.0 mm.

species might be estimated. If in the future these areas are more thoroughly surveyed by quantitative methods, the faunistic differences or peculiarities will be more clearly demonstrated. For the same reason, present data are presumed to be insufficient for the following discussion and a supplemental report is to be expected.

Geographical Differences of the Assemblages

Within the Izu Banks, local differences in the assemblage are scarcely observed. The typical species-groups found in the area are roughly subtropical or warm-temperate forms from the lower part of the continental shelf bordering the main Japanese islands. On the other hand, probably because of the differences in latitude, a slight difference exists between the faunas of the northern half and those of the southern half of the Izu Banks.

Geographically, the Izu Islands and the Osumi Group are distant from each other. Similar patches of banks are not found between the Izu Banks and the Osumi Banks. Therefore, the continuity or discontinuity of the fauna has not yet been studied. However, many species are found in both areas: *Arca mauia takii* Hatai, Niino, and Kotaka; *Acar congenitum* (Smith); *Samacar pacifica* (Nomura and Zimbo); *Hawaiarca uwaensis* (Yokoyama); *Mimarcaria aizoi* Sakurai (MS); *Striarca fausta* Habe; *Chlamys vesiculosus* (Dkr.); *C. tissotii* (Bernardi); *C. lemniscata* (Rve.); *C. mollita* (Rve.); *Spondylus anacanthus* (Mawe); *Plicatula muricata* (Sowerby); *Frigidocardium eos* (Kuroda); *Chama argentata* Kuroda and Habe; *Tenagodus anguinus* (L.); *Bursa ranelloides* (Rve.), var.; and *Conus* sp.

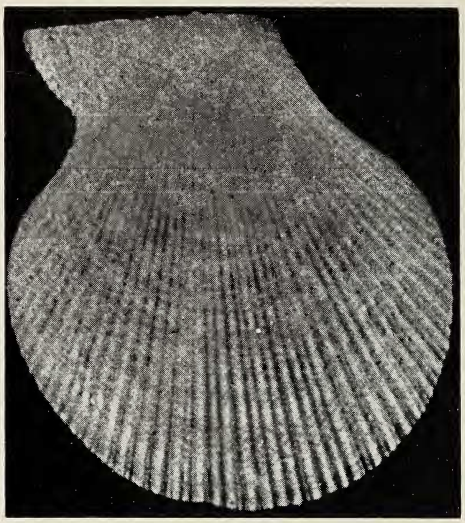

FIG. 14. *Chlamys mollita* (Reeve) from Hyotanse, 118 m, 18.5 mm × 17.0 mm.

Of the species that are not common to the two areas, some forms are apparently ecological equivalents of banks-associated forms. Several examples are shown here:

IZU ISLANDS AREA	OSUMI STRAITS AREA
Perotrochus beyrichii (Hilgendorf)	*P. salmiana* (Rolle)
Galeoastraea guttata (A. Ad.)	*G. millegranosa* Habe or *G. tayloriana* (Smith)
Tucetona shinkurosensis Hatai, Niino, and Kotaka	
Lima fujitai Oyama	*L. tomlini* Prashad?
Glans sagamiensis Kuroda and Habe	*G. kyushensis*, sp. nov.

Possible Vertical Limits of the Banks-Associated Fauna

The distribution of the benthic mollusca is governed much more forcefully by the substratum of the depths than by other environmental factors. At equal depths in similar latitudinal position, or under the same ocean climate, the differences in representation are due to such bottom factors as mud, sand, gravel, and rock. The banks-associated molluscan assemblages shows mainly hard-bottom facies mingling with some sandy bottom dwellers of the depths. This is closely associated with the insular shelf fauna, since the surrounding areas of almost all the small islands in the region are

almost entirely rocky. On the other hand, this is not always similar to the shelf fauna of the main islands because the shelf bordering the main islands does not always present a hard bottom. For instance, a molluscan assemblage from the soft bottom within Sagami Bay at a similar depth ("Soyo" sta. T26, Nov. 15, 1958, 35° 15.4′ N, 139° 27.9′ E, 102 m) is made up of: *Glycymeris rotunda* (Dkr.); *Delectopecten macrochrilicola* Habe (believed to be found attached to the carapace of the giant spider crab, but recently recovered as free living individuals); *Venus faveolatus* Sowerby; *Onustus exutus* (Reeve); *Granulifusus niponicus* (Smith). Moreover, collections from a certain area in Sagami Bay sometimes contain species similar to those from the banks under study (cf *12* and *13*), while a different assemblage is found from another hard bottom in the Bay at the same level. Therefore, the most remarkable character of a banks-associated assemblage is the constant occurrence and constant dominancy of the typical species of the area.

The typical banks-associated assemblage appears at depths ranging from 32 m as the shallowest to 290 m as the deepest, centering around 100–250 m. In waters shallower than this, a certain upper-shelf assemblage is observed, which is frequently collected by a lobster-net or in *Gelinidium* collecting. Examples of hard-bottom dwellers in the shallower zones of the Oshima Islands are: *Turbo cornutus* (Solander); *Fusinus nicobaricus* (Lamarck); *Fasciolaria glabra* (Dkr.); *F. trapezium audouini* (Jonus),

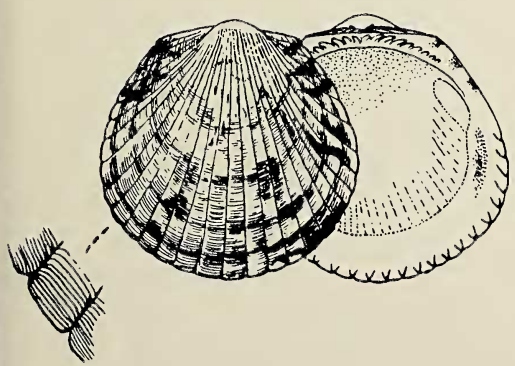

FIG. 15. *Tucetona shinkurosensis* Hatai, Niino, and Kotaka from Niijima-Nishitai, 14 mm in height.

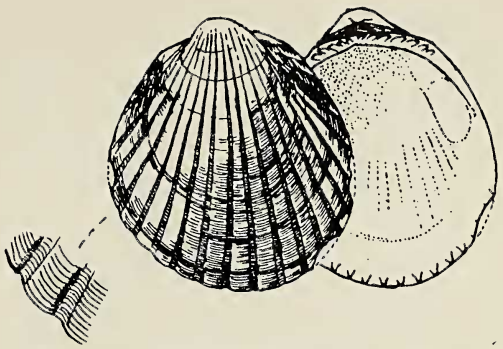

FIG. 16. *Tucetona hanzawai* (Nomura and Zimbo) from Kikaijima (fossil).

etc. The sandy bottom facies of the upper shelf in Okada, Oshima Island, is reported by the dominance of the following species: *Terebra nebulosa* Sowerby; *Conus tessulatus* Born; *Chlamys vesiculosus* (Dkr.); *Callista pilsbryi* Habe; *Dosinia iwakawai* Oyama and Habe; *Antigona lamellaris* Schumacher; *Sunetta concinna* (Dkr.), var.; *Paphia amabilis* (Philippi).

Judging from these observations, the ecotone between a shallow insular shelf fauna and a lower insular shelf fauna, which is almost equivalent to banks-associated fauna, is presumably at a depth of 50 m or so. The deeper limit may be about 300 m. For example, at a station near Okinoyama, about 300 m deep, the following species were collected from a gravel bottom ("Soyo" sta. T20'C, Aug. 11, 1958, 34° 59.0′ N, 139° 32.3′ E) despite the fact that the similar banks-associated assemblage is observed on the upper part of this bank: *Chlamys* sp. aff. *mollita* (Rve.); *Delectopecten macrocheilicola* Habe; *Keenaea sakuraii* Habe; *Pandora* sp.; *Turcicula crumpii* Pilsbry; *Trophonopsis echinus* (Dall); *Japonacteon archibenthicola* Habe. Gravels from such depths are not covered by calcareous algae.

This archibenthal assemblage almost agrees with that found from similar depths near Omurodashi reported by Igarashi and Kurata (1956). As has been stated, the molluscan community on the islands near the banks under study is allied to those from neighboring banks; while, out of biological dredge samples from stations lower than that, at a depth of 470–480 m, near Hachijo Island, a different archibenthal molluscan assemblage is found ("Soyo" sta. B3, March

20, 1958, 33° 07.5′ N, 140° 03.2′ E, 480 m and *do.* Nov. 17, 1958, 33° 10.0′ N, 140° 02.7′ E, 470 m): *Fusinus?* sp.; *Trophonopsis echinus* (Dall); *Neptunea constricta* (Dall), var.; *Benthovoluta* sp.; *Conus* sp. nov. The bottom is found to be of volcanic gravel which is not coated by algal matter.

SUMMARY AND CONCLUSION

As the result of examination of biological dredge samples taken from submarine banks around the Izu Islands, it became clear that possible characteristic banks-associated molluscan assemblages are found in this area. Since they are closely associated with the bottom nature and the depth of the banks, the assemblages are composed mostly of the hard-bottom lower shelf fauna found on the southwestern Pacific coast of the Japanese main islands.

The present material was collected at random with various kinds of gear, so that a quantitative analysis of the fauna was not possible. However, constant occurrence and relative abundance of certain species were assumed as indicators of the fauna of the areas. The typical banks-associated molluscan assemblages from the Izu Islands area are possibly represented by such gastropods as *Perotrochus beyrichii, Galeoastraea guttata,* and *Tenagodus anguinus,* together with several pelecypods such as *Acar congenitum, Arca mauia takii, Hawaiarca uwaensis, Samacar pacifica, Mimarcaria aizoi, Tucetona shinkurosensis, Chlamys vesiculosus, C. tissotii, C. lemniscata, C. mollita, Spondylus anacanthus, Plicatula muricata,* and *Lima fujitai.*

FIG. 17. *Chama argentata* Kuroda and Habe from insular shelf of Takeshima Is., 11.6 mm × 10.1 mm.

FIG. 18. *Spondylus anacanthus* (Mawe) from Uji Islet, 126 m, 40.2 mm × 37.5 mm.

The geographical difference of the assemblage within the area is not so obvious, but it is clear that the insular shelf fauna is substantially the same as that under discussion. It seems that the species found in the area are those distributed also in warmer districts. This impression may be corroborated by facts such as these:

1) Similar banks-associated assemblages are found in southern waters off Kyushu which are much more subtropic in average climate.
2) *Tucetona hanzawai* and *Samacar pacifica,* which are found from the Izu Islands area, were originally described by Nomura and Zimbo (1934) from the Ryukyu Limestone of Kikaijima (or Kikai-ga-shima), an island located far to the southwest of the Osumi Group. Concerning the fossil fauna found from this Ryukyu Limestone, Nomura and Zimbo cited Yabe and Hanzawa's opinion that the Ryukyu Limestone was deposited in waters warmer than are found there at the present time, and that fossils found there are very similar to the recent fauna found around the

FIG. 19. *Lima fujitai* Oyama from Hyotanse, 118 m, 15.5 mm × 12.0 mm.

Ryukyu Archipelago, which is situated farther south than Kikaijima Island.

3) *Striarca fausta* is another example described from a fossil bed (at Moeshima in Kagoshima Bay, Kyushu) containing warmer water species.
4) Some elements of tropical origin are found in the banks fauna, e.g., *Chicoreus superbus,* which has been known from the Bonin (or Ogasawara) Islands, and *Arca mauia takii,* which is presumably an endemic form of a Hawaiian species. These two species are found at Kurose, which is the most southern bank in the area.

An assumption that the molluscan assemblage of the Izu Banks is an isolated shelf fauna representing species derived from warmer water corresponds to that of Parker and Curray (1956: 2438) for the Gulf of Mexico. They concluded from their studies that the banks-associated molluscan assemblages in waters off Texas represented a population now isolated from the main centers of abundance ranging from southeast Florida to the West Indies and different from the surrounding level-bottom communities.

According to Teramachi (personal communication), there are some distributional gaps of upper-shelf mollusca even within the warm Kuroshio area, though they are far less conspicuous than those existing at about 36° N on the Pacific coast of Honshu. One such type of gap presumably is found around Ashizuri-Saki, for instance. The distributional difference of certain species of *Fusinus, Siphonalia, Ancilla,* and *Fulgoraria* off the east and west coast of the cape (about 34° 42′ N, 133° E) may be found there. Regardless of this fact, the typical

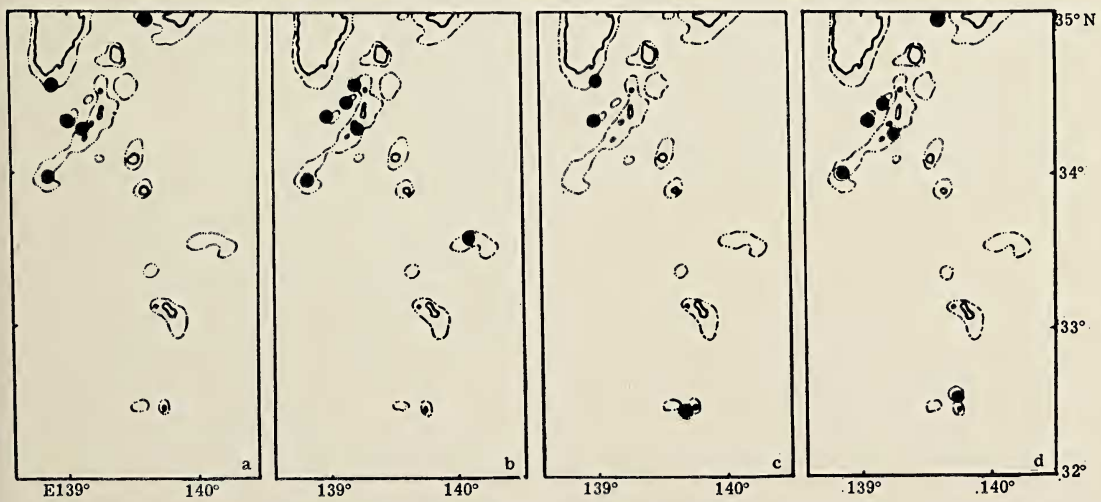

FIG. 20. Distribution of bank-associated mollusca. *a, Galeoastraea guttata; b, Tucetona shinkurosensis; c, Chama argentata; d, Spondylus anacanthus-Lima fujitai-Plicatula muricata* (or any two of these).

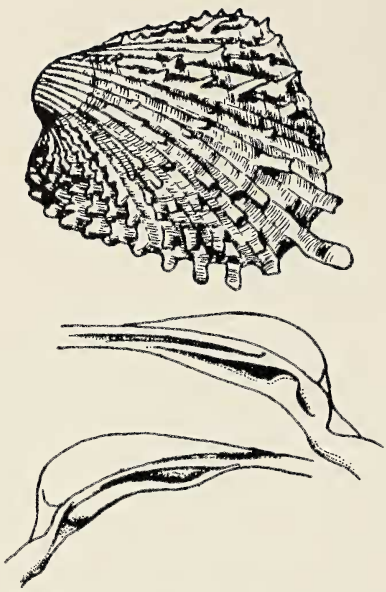

FIG. 21. *Glans kyushuensis*, sp. nov. (holotype), 16.0 mm × 13.0 mm × 5.5 mm.

banks-associated molluscan assemblages are found from the discontinuous biotopes, i.e., southwestern Kyushu (about 129° 30′ E) and Izu Islands areas (about 140° E). Latitudinally, they are distributed from the southern tip of Izu Peninsula (34° 34′ N) southward to Torishima Island (30° 30′ N).

Above all, this study shows how marine mollusca on the same level under similar ocean climate are governed in their distribution by the substratum. Moreover, a particular molluscan assemblage (or simply a combination of the species) can serve to indicate the sedimentary characteristics of the banks in the Kuroshio area.

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APPENDIX

Glans kyushuensis Okutani, sp. nov. (Carditidae)

Shell equivalve, closed, stout, gibbous in

shape; quadrangular in outline; beak anteriorly oblique; surface rough, uniformly pink in color, sometimes with delicate wavy pattern of darker color on posterior region; radial ribs running from umbo to distal margin, 20 or 21 in number, as wide as shallow interspacial grooves, granulated on anteroventral ones, while sparsely spinose on rest; longest spinose scale as long as ⅕ of shell length; escutcheon narrow; lunule deeply impressed, cordate in outline.

Interior smooth, with shallow radial grooves; ashy white with pinkish tint; on right valve, anterior cardinal teeth vestigial, while posterior ones elongated; on left valve, anterior cardinal teeth short, small but prominent, posterior ones elongated, plate-like in shape; ventral margin crenulated; mantle scar smooth.

LOCALITY: 35° 50′ N, 130° 28.5′ E, 210 m in depth, gravels and shell.

TYPES: Left odd valve: 16 mm long, 13 mm high, 5.5 mm thick (holotype). Left odd valve: 13 mm long, 11.5 mm high, 5 mm thick (paratype). Right odd valve: 18 mm long, 16 mm high, 7 mm thick (paratype).

REMARKS: This new species is closely allied to *G. hirasei* (Dall),[2] but the latter has more radial ribs which are closely scaly. This new species is distinguished from *G. millegranosa* (Nomura and Zimbo), [3] which has a strongly inflated shell and granulated radial ribs.

DISTRIBUTION: The type locality and off Kii Peninsula (collected by Mr. Teramachi; conjoined valve measures 24 × 20 × 18 mm).

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[2] Dall, 1918: Proc. U. S. Nat. Mus. 54(2234): 234.

[3] Nomura and Zimbo, 1934: Sci. Rept. Tohoku Imp. Univ., 2nd ser., 16(2): 154(45), pl. v(i), figs. 13a, b, 14a, b. Also Okutani, 1958: Venus 20: 220, tfs. 2, 3.